THE BRITISH COMPUTER SOCIETY

THE BCS PROFESSIONAL EXAMINATION
Diploma

OBJECT ORIENTED PROGRAMMING (Version 1: Old Syllabus)

21st April 2004, 2.30 p.m.-4.30 p.m.
Answer FOUR questions out of SIX. All questions carry equal marks.
Time: TWO hours.

*The marks given in brackets are **indicative** of the weight given to each part of the question.*

1. A University's library stores various items that can be borrowed, including books and journals. Both staff and students can borrow books, but only staff members can borrow journals. Students can borrow up to a maximum of 5 books and staff can borrow up to a maximum of 10 books and 3 journals. Books can be borrowed for two weeks and journals one week. If the borrower keeps the book or journal longer than this, they are subjected to a fine, which is increased daily.

When a user borrows a book, they provide their *libraryId*, if this is valid their loan details are checked to ensure that they have not already borrowed above the maximum permitted number of books. They will not be allowed to borrow above the maximum number. A check is also made to see if they have any fines. If they have a fine, then they cannot borrow any items until the fine is paid. If all the checks are ok, then the item is issued to the user and the return date is assigned to the loan. At this point the user can optionally ask for a printout, which summarises all of the items they have on loan and when each item is due back.

Users can check their own loan details at any time. Librarians are permitted to check the loan details of any user.

Library users can reserve books that are currently out on loan. Journals can not be reserved. If three reservations have already been made for a given book, and a further reservation is made, a new copy will be ordered by the librarian.

a) Draw a use case diagram for the library system. **(15 marks)**

b) Write down a use case description of the way a user borrows a book. Your answer should include a normal sequence and three alternative sequences. **(10 marks)**

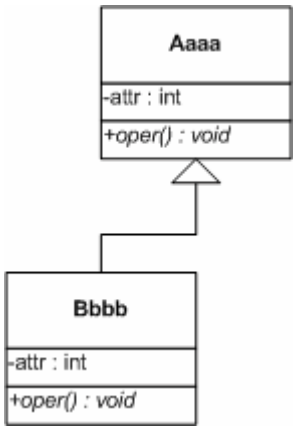
2. *a)* Carefully explain the occasions on which you would use the following:
i) a constant instance variable (or field)
ii) a class variable (or field)
iii) a class method (or operation)
iv) a concrete class
v) an abstract class **(10 marks)**

b) A lending library holds a large number of publications that may be books or journals. Both are given a title e.g. “Object-Oriented Programming” and a unique reference number e.g. 123. The reference number is not expected to change. In addition each book also has an author e.g. “John Smith” and an international standard book number e.g. 0-13-12344567-8. Each journal also has a date of publication e.g. 15-12-2003 and the name of its editor. Finally all publications in the library need to hold the name of the library they are in e.g. “City Library”.

Using an object-oriented programming language of your choice, provide sample code that demonstrates the use of the five concepts in part *a)* above when implementing the lending library scenario. **(15 marks)**

3. *a)* Describe in detail **TWO** design patterns with which you are familiar. Your answer should include the circumstances in which they are applicable, when they can be applied and trade-offs when using them within a larger design. **(16 marks)**

b) The following class diagram includes the classes Aaaa and Bbbb in which the latter is a specialisation of the former. Both classes include a definition for the method oper and the attribute attr. Identify any issues arising from this arrangement and consider their implications. **(9 marks)**



4. *a)* Explain the following terms:
i) Object
ii) Class
iii) Inheritance
iv) Superclass
v) Subclass **(10 marks)**

b) Object oriented programming languages implement *inheritance*, some languages however implement *single inheritance* whilst others implement *multiple inheritance*. Distinguish between these types of inheritance and discuss why a language designer might choose to implement one but not the other. **(5 marks)**

c) A bank operates accounts. The basic operations on accounts are deposit() and withdraw(). The bank operates a number of types of accounts amongst which are savings accounts and current accounts. Savings accounts have no overdraft facility associated with them. Current accounts have a limited overdraft facility. Using an object-oriented language with which you are familiar, develop code which shows how inheritance and polymorphism can be used to model the bank. **(10 marks)**

5. *a)* Give the meaning of the following terms:
i) Abstraction
ii) Encapsulation
iii) Data hiding **(9 marks)**

b) A programmer wishes to create a set of classes that implement collections (e.g. Set, SortedSet, List, SortedList). Explain how abstraction, encapsulation and data hiding can be used to create generic classes for this purpose. **(10 marks)**

c) Describe the contribution that abstraction, encapsulation and data hiding make to the potential of a language to encourage software reuse. **(6 marks)**

6. *a)* Give a simple example of each of the following diagrams and describe the context in which you would use them.

i) Use case diagram

ii) Object interaction diagram (sequence diagram or a collaboration diagram)

iii) State transition diagram **(15 marks)**

b) Describe an approach you might follow to derive test cases for a software product from the use case diagrams that specify it. **(10 marks)**